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GB 0531798
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GB 0397651

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(54) Coupling arrangements for coaxial cables

(57) British Standards BS6513 Part 4 Section 3 requires isolation of subscriber equipment from a T.V. cable network at mains frequency and voltages. The coupling arrangement described provides a wideband (5-450 MHz) coupling using a transformer T between cable sections. Additional isolation at mains frequency is provided by capacitors C2, C3 in series with one transformer winding. The transformer T and isolating capacitors C2, C3 are connected in a screening enclosure 46, 48 which includes series capacitance elements C1a, C1b, that isolate the cable screens at mains frequency but allow return current to flow without significant radiation at the high end of the frequency range where leakage capacitance coupling through the transformer T is not negligible. In a modification, a ferrite bead (54, Figure 3) is mounted over one cable section, the series capacitive element being completed on the transformer side of the bead, and a further capacitive element being connected between the screen enclosure on the other side.

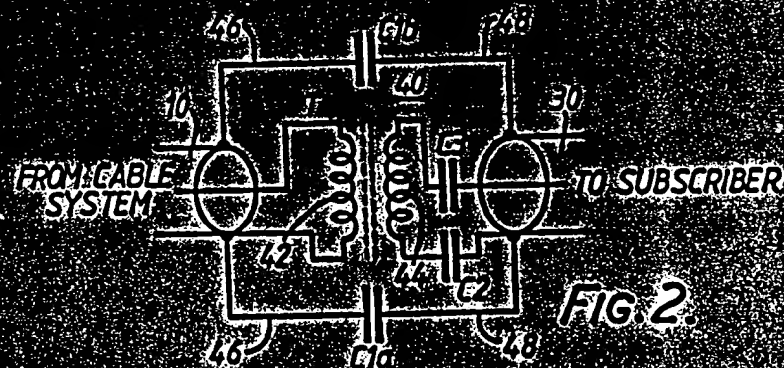

FIG. 2.

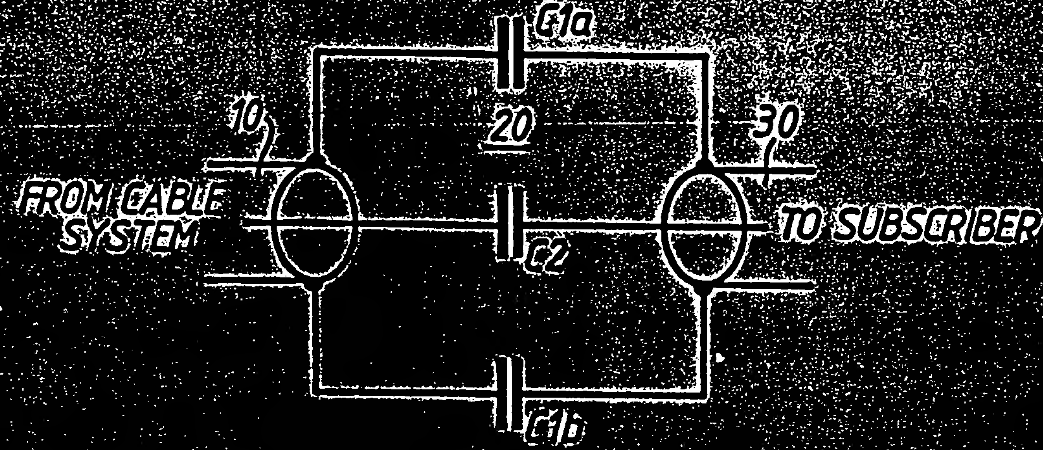

FIG. 1.

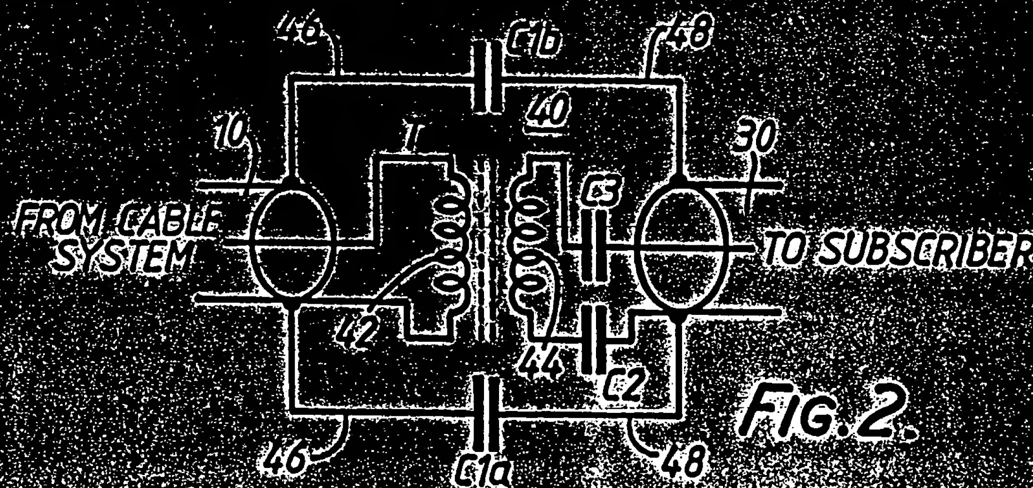

FIG. 2.

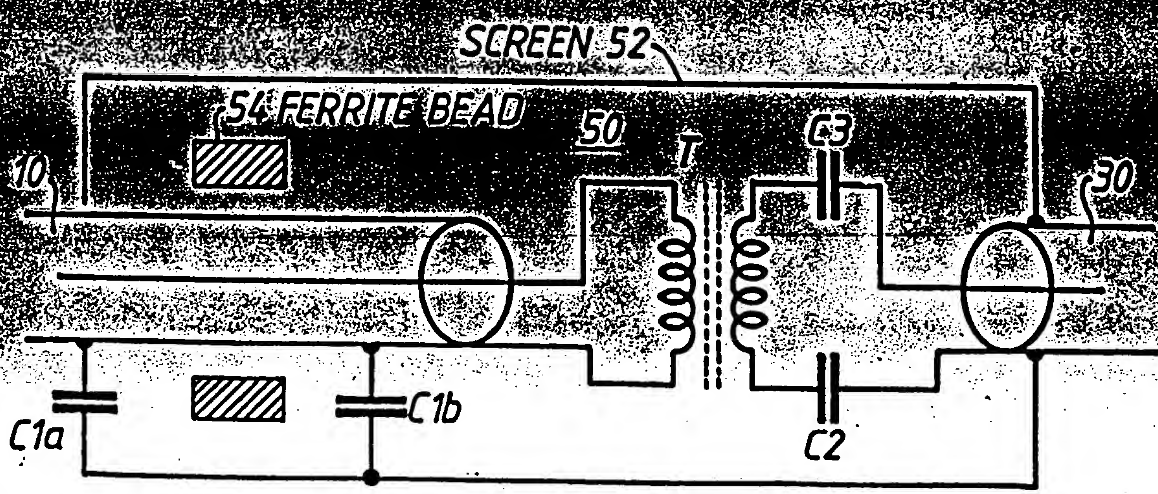

FIG. 3.

SPECIFICATION

Coupling arrangements for coaxial cables

This invention is concerned with the coupling of signals between two sections of cable where isolation has to be provided in respect to other voltages which may be present, particularly mains (power line) voltage. Such requirements arise in cable systems where subscribers are connected in to a cable network. Faults may arise which could cause mains voltage to be applied at some point in the system.

In many countries a coaxial cable connected to a subscriber's equipment is separated from the network coaxial cable as regards mains voltage by a series capacitor connected between the two inner conductors and of a value suitable for coupling the cables at signal frequencies but effectively isolating them at the mains frequency. The two screens or outer conductors of the cables are connected together and grounded for safety. In the United Kingdom it is required to isolate the cables so that they are separated at their outer screen as well as at their inner conductors.

British Standards (BS6513, Part 4, Section 3) specifies requirements placed on the isolation of subscriber equipment from a TV cable network at mains frequency and voltages. Such isolation can be achieved by using respective capacitors in series with the inner and outer conductors of the coaxial cable feeder to the subscriber. To separate the two cable sections as regards mains frequency the value of the coupling capacitors is limited to about 5nF in order to keep any mains current flow to a low level. Such isolating capacitors have satisfactory performance to the wanted system signals coupled through them, where such signals are above about 50 MHz. As the signal frequency becomes lower the impedance of the coupling capacitors becomes increasingly significant which leads to the development of a significant signal voltage across the coupling capacitors and, therefore, between the screens of the coaxial cable sections. This causes unacceptable levels of radiation. It is also susceptable to signal ingress.

A cable system may well require wideband operation extending from say 5 MHz up to 450 MHz or even higher in frequency. It will be appreciated from what is said above that a simple capacitor isolation between the cable sections will not suffice.

An alternative means of providing isolation is to use a transformer coupling between cable sections. A transformer is suitable for coupling lower signal frequencies but tends to cause high levels of radiation at higher signal frequencies. The radiation can be prevented by providing electrostatic screening between the transformer windings but the added capacitance and size due to the electrostatic shield greatly distorts the frequency response of the transformer. Thus a simple transformer coupling is not suitable for the kinds of wideband systems envisaged above.

There will be described hereinafter cable coupling arrangements embodying the present invention which meet the requirements of the quoted British Standard in a wideband cable system while at the same time mitigating the problem of unwanted radiation or pick up of unwanted signals.

Aspects and features of the invention are set out in the claims appended to this description.

The invention and its practice will be further described with reference to the accompanying drawings, in which:

Figure 1 is a circuit showing the application of capacitor-only coupling to provide mains frequency isolation between sections of coaxial cable;

Figure 2 is a circuit of one embodiment of a coupling arrangement in accord with this invention; and

Figure 3 is a circuit of a second embodiment of a coupling arrangement in accord with the invention.

Referring to Figure 1, there is shown a coaxial cable 10 leading from a wideband cable network coupled by a capacitor arrangement 20 to a coaxial cable 30 leading directly to subscriber's equipment. The capacitor arrangement includes capacitors C1*a*, C1*b* connected between the screens of the cables and a capacitor C2 connected between the two inner conductors. For the reasons given above the capacitors are limited to about 5 nF to provide the required mains frequency isolation. This value is the limit of the total capacitance (C1) coupling the screens.

In a wideband system covering say 5 to 450 MHz the capacitors have sufficient impedance at wanted signal frequencies at the lower frequency portion of the band to develop a significant voltage across them. The reasons for showing the screen coupling capacitance (C1) as more than one capacitor is that the capacitors C1*a*, C1*b* could be made part of a screening enclosure screening the inner capacitor C2. However, the signal voltage across the capacitance C1 at lower frequencies produces a difference in voltage between the screens on each side and causes radiation. The development of the signal voltage across C1 is a reflection of the non-uniform frequency response of the capacitor arrangement. The substitution of the simple capacitor coupling arrangement by a simple transformer coupling is not satisfactory for the reasons given above.

Figure 2 shows a coupling arrangement 40 in accord with the invention which uses a combination of capacitance and transformer coupling to provide a wideband coupling without undue radiation arising.

The cable sections 10 and 30 are transformer coupled by a transformer T having separate windings 42 and 44 connected across the inner and outer conductors of cable 10 and cable 30 respectively so that there is an inherent isolation against the unwanted application of mains voltage to one cable section being transferred to the other. The transformer T comprises a core of ferrite material and specifically a ferrite bead through which is wound the windings 42 and 44. Such a bead transformer may not be capable of reliably withstanding mains voltage occurring thereacross as a result of a fault. Additional isolation capacitors can be provided. Figure 2 shows two such capacitors C2, C3 connected on one side of the transformer T and isolating both ends of the relevant winding from the screen and inner conductor of the associated cable section. In addition to the transformer T the coupling arrangement 40 of Figure 2 in-

cludes capacitive coupling between the screens of the cable sections. Two (or more) capacitors C1*a* and C1*b* are used forming part of a screened enclosure of conductive material for the transformer T. The enclosure could be in two parts providing conductors 46 and 48 connecting with the capacitors C1*a* and C1*b*. The total coupling capacitance will be referred to as C1. The enclosure could effectively provide a capacitor of cylindrical form and coaxial with the transformer T. Thus in this respect the circuit as drawn reflects the physical layout as well as the electrical connections.

Operation of the coupling arrangement 40 is as follows, at low frequencies signals are transmitted by normal transformer action and coupling by stray capacitance between the windings 42, 44 is small. Therefore, only a negligible amount of signal will flow in the coupling capacitance C1. The screens of the cable sections 10 and 30 will thus be at essentially the same potential as regards wanted signal frequencies and will not radiate.

At higher frequencies the stray capacitance in the transformer provides a capacitive signal coupling component in addition to the wanted transformer coupling with a consequent flow of signal through capacitance C1. However, at these higher frequencies the impedance presented by the coupling capacitance C1 is sufficiently small to maintain the essentially equi-potential conditions of the screens so that radiation is minimal. The enclosure or screening extending between the cable sections 10 and 30 and in which the isolating capacitance C1 is located should surround the transformer as completely as possible to prevent escape of radiation from the transformer.

Figure 3 shows a modified embodiment. The coupling arrangement 50 uses a ferrite bead transformer T as in Figure 2 that is enclosed in a screening enclosure 52 one end of which closely fits and is connected directly to the screen of one cable section 30 and the other end of which allows the cable section 10 to pass through it and is coupled to the screen of cable 10 by capacitors C1*a*, C1*b*. Unlike in Figure 2 these capacitors do not function identically in that they are connected to spaced points on the screen of cable section 10 between which points the cable passes through a ferrite bead or ring 54.

The ferrite bead 54 provides an inductance along the cable between the points at which capacitors C1*a* and C1*b* are connected and thus a high impedance to longitudinal current flowing in the cable thereby effectively providing with transformer T a balun type of transformer. Furthermore the inductance provided by bead 54 forms a low pass filter with capacitors C1*a* and C1*b*. At higher frequencies the capacitive signal component transmitted by the transformer T requires a signal curr nt flow in the screen as in Figur 2 and this is coupled back t the screen f cabl section 10 by capacitor C1*b*. Any voltage developed at C1*b* is small as in the circuit f Figure 2 and is further attenuated by the low pass filter to appear at much reduced level across capacitor C1*a*. It will be appreciated that each of capacitors C1*a* and C1*b* could be constituted by a number of capacitors disposed around the cabl section 10.

In both th circuits of Figures 2 and 3 the ferrite core transf rmer provides a transformer coupling between the cable sections over the lower porti n of the frequency band covered with negligible stray capacitive coupling, thereby av iding signal current in the screen coupling capacitance C1. At the frequencies at which the stray capacitance component becomes of some significance, the impedance of capacitance C1 is sufficiently low t ensure little or no radiation from the screens f the cables.

In the practical implementation of the coupling arrangements of Figures 2 and 3 to cover the range 5-450 MHz, the capacitors C2 and C3 may each be 5nF. The characteristic impedances of the cable sections are equal, for example 75 ohms. The ferrite bead transformer is of 1:1 ratio and provides transformer coupling over the entire frequency range. A typical value of primary inductance to achieve the desired frequency response at 5MHz is 15 μH.

CLAIMS

1. A coupling arrangement connected between two sections of coaxial cable to couple signals from one cable section to the other over a predetermined band of frequencies and to isolate the cable sections at mains (power line) frequency, comprising:
a transformer having respective windings connected to said cable sections for coupling signals therebetween over at least a lower frequency portion of said band; and a screening enclosure connected between the screen conductors of the coaxial cable sections and including series capacitance acting between the screen conductors of a value to provide a low impedance signal coupling between the two screens at least over a higher frequency portion of said band while providing high impedance between the cable screens at mains frequency to isolate same.

2. A coupling arrangement insertable between two sections of coaxial cable for coupling signals over a predetermined band of frequencies from one section to the other comprising:
a transformer having respective windings for connection to said coaxial cable sections for coupling signals therebetween over at least a lower frequency portion of said band; and
a screening enclosure connectable between the screen conductors of the two cable sections and including capacitance of a value providing a low impedance signal coupling between the two screens at least over a higher frequency portion of said band while providing high impedance between the cable screens at mains (power line) frequency to isolate same.

3. A coupling arrangement as claimed in Claim 1 or 2 in which the transformer comprises a core of ferrite material having th windings th reon.

4. A coupling arrangement as claimed in Claim 1, 2 or 3 in which at least ne f the windings has a respective series capacitor connected to each end of the winding of a value for providing high impedance isolation between the cable sections at mains frequency.

5. A coupling arrangement as claimed in Claim 1 and 3 in which at least one of the windings has its

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ends connected to the inner and screen conductors of the associated cable section through respective capacitors of a value providing a high impedance isolation between the cable sections at mains frequency.

6. A coupling arrangement as claimed in any preceding claim in which the screening enclosure is in two parts connectable or connected, as the case may be, to the screens of respective cable sections and with the coupling capacitance acting between the two parts.

7. A coupling arrangement as claimed in any one of Claims 1 to 5 in which the screening enclosure is in one part connected or connectable, as the case may be, directly to the screen of one cable section, the coupling capacitance comprising at least one capacitor connected to the screening enclosure, and connected or connectable, as the case may be, to the other cable section.

8. A coupling arrangement as claimed in Claim 1 in which one section of coaxial cable passes through a ferrite ring or bead adjacent the transformer and the coupling capacitance of the screen enclosure comprises capacitance connected between the enclosure and the screen of the one cable section on the transformer side of the ferrite ring or bead.

9. A coupling arrangement as claimed in Claim 8 in which the coupling capacitance includes further capacitance connected between the enclosure and the screen of the one cable section on the side of the ferrite ring or bead remote from the transformer.

10. A coupling arrangement as claimed in Claim 8 or 9 in which the enclosure is directly connected to the other cable section.

11. A coupling arrangement as claimed in Claim 8, 9 or 10 in which the transformer comprises a core of ferrite material having the windings thereon.

12. A coupling arrangement as claimed in Claim 8, 9, 10 or 11 in which at least one of the windings has its ends connected to the inner and screen conductors of the associated cable section through respective capacitors of a value providing a high impedance isolation between the cable sections at mains frequency.